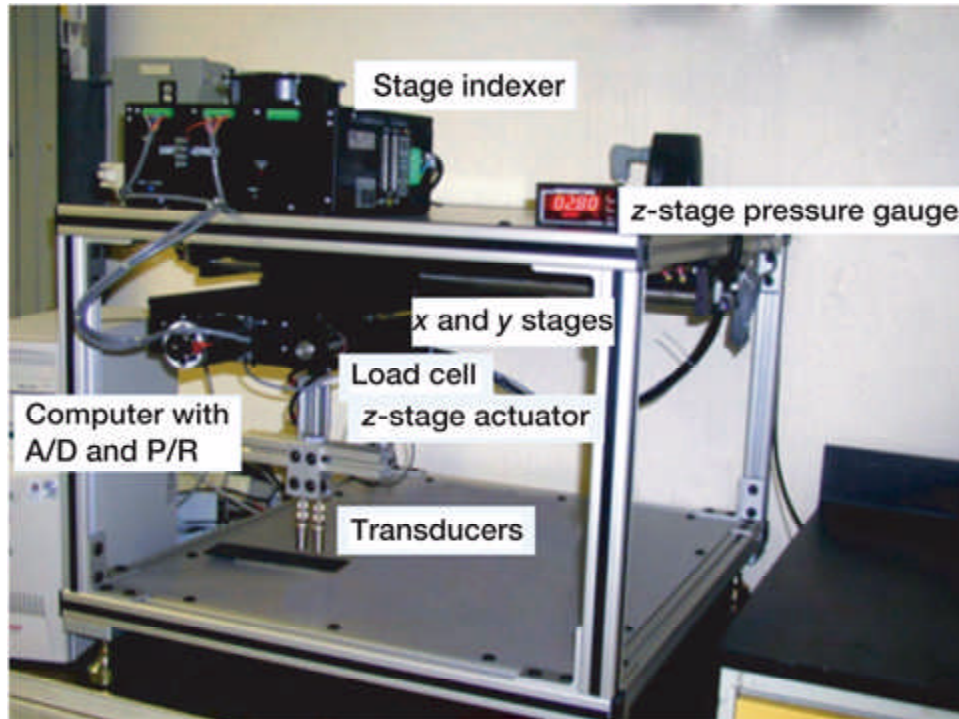


Automated Guided-Wave Scanning Developed to Characterize Materials and Detect Defects



Guided wave scanner setup. A/D, analog-to-digital converter; P/R, pulser-receiver.

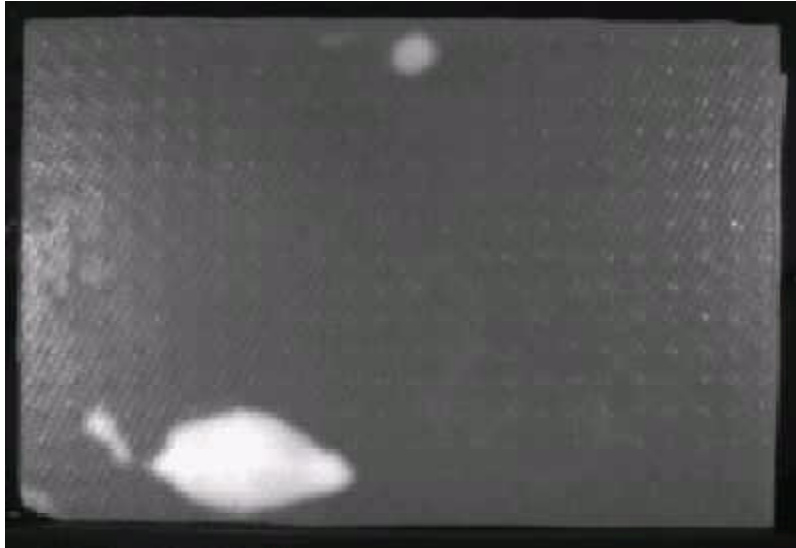
The Nondestructive Evaluation (NDE) Group of the Optical Instrumentation Technology Branch at the NASA Glenn Research Center has developed a scanning system that uses guided waves to characterize materials and detect defects. The technique uses two ultrasonic transducers to interrogate the condition of a material. The sending transducer introduces an ultrasonic pulse at a point on the surface of the specimen, and the receiving transducer detects the signal after it has passed through the material. The aim of the method is to correlate certain parameters in both the time and frequency domains of the detected waveform to characteristics of the material between the two transducers.

The preceding photograph shows the scanning system. The waveform parameters of interest include the attenuation due to internal damping, waveform shape parameters, and frequency shifts due to material changes. For the most part, guided waves are used to gauge the damage state and defect growth of materials subjected to various mechanical or environmental loads. The technique has been applied to polymer matrix composites, ceramic matrix composites, and metal matrix composites as well as metallic alloys. Historically, guided wave analysis has been a point-by-point, manual technique with waveforms collected at discrete locations and postprocessed. Data collection and analysis of this type limits the amount of detail that can be obtained. Also, the manual movement of

the sensors is prone to user error and is time consuming. The development of an automated guided-wave scanning system has allowed the method to be applied to a wide variety of materials in a consistent, repeatable manner. Experimental studies have been conducted to determine the repeatability of the system as well as compare the results obtained using more traditional NDE methods. The following screen capture shows guided-wave scan results for a ceramic matrix composite plate, including images for each of nine calculated parameters. The system can display up to 18 different wave parameters. Multiple scans of the test specimen demonstrated excellent repeatability in the measurement of all the guided-wave parameters, far exceeding the traditional point-by-point technique. In addition, the scan was able to detect a subsurface defect that was confirmed using flash thermography (see the final figure).



Front panel display of results for a guided wave scan of a composite plate. Each subimage represents a different guided wave parameter.



Pulsed thermography results for a ceramic composite plate. The lighter area indicates the location of a subsurface flaw.

This technology is being further refined to provide a more robust and efficient software environment. Future hardware upgrades will allow for multiple receiving transducers and the ability to scan more complex surfaces. This work supports composite materials development and testing under the Ultra-Efficient Engine Technology (UEET) Project, but it also will be applied to other material systems under development for a wide range of applications.

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